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ABSTRACT

A brief introduction to the periodic table of the elements is presented. The periodic relationships are demonstrated through the use of seven tables which include a breakdown of the periodic table by groups or families, valence ring electron populations by period, electronic configurations of the elements, electron configurations of the elements by groups, ionization energies by family for the first three periods, atomic and ionic radii by group, and atomic and ionic radii by period. (BB)

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AN INTRODUCTION TO THE PERIODIC LAW FOR GENERAL CHEMISTRY STUDENTS

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INTRODUCTION

When the elements are arranged in the order of increasing atomic number, similarities in physical and chemical properties are repeated at regular intervals. The arrangement implied in this statement is the periodic table (Figure 1).

The table, as most chemistry students soon come to know, is divided horizontally in periods and vertically in groups or families. Accordingly, there are seven periods plus the lanthanide and actinide series, seven groups or families plus the noble gases (sometimes called the inert or nonreactive gases). As the law states, the table is arranged in a predictable manner. It is this manner of arrangement with which we concern ourselves here.

THE TABLE

In the table (Figure 1) elements are arranged horizontally according to their atomic numbers. Each successive element has an atomic number - one greater than its predecessor. Since the atomic numbers indicate the numbers of protons each element has, it can be said that the periodic table is arranged horizontally by increasing atomic mass. Each time the outer most energy level of an element has eight electrons, the maximum extension of the table has been reached in the right-hand direction. Therefore, the right end of each period is ended with one of the nonreactive gases.

A new period always begins at the left-hand edge of the table and the first element in the period always has an atomic number - one greater than the nonreactive gas in the period directly above it. Because atomic numbers of the elements increase from the top to the bottom of the table, as well as from left to right, elements of greatest atomic mass should be found in the lower right-hand corner of the table. Most chemistry texts leave students at this point. From here on students are left to extrapolate the additional reasons for such a periodic arrangement and, subse-

quently, the types of phenomena this arrangement creates.

Many of the reoccurring relationships which exist as a result of this elemental arrangement must be abstracted from handbooks of chemistry and physics. Others come from relating element electron populations, valence ring electron populations and the like, to the periodic table arrangement.

In an effort to facilitate student understanding of the periodic relationship among the elements, seven tables were constructed in a manner such that periodic trends might be evaluated, both from a periodic and a group or family perspective.

Table 1 provides a breakdown of the periodic table by groups showing the electron populations of each orbital of each element. Included in this table, also, are the ionic or oxidation states each of the elements may assume. Additionally, an asterisk is included after the electron population in each valence ring.

An evaluation of Table 1 shows several interesting reoccurring trends. An element, generally speaking, has the ability to assume at least one ionic state equal to the value of the family number. Again, generally speaking, the electron population of the valence orbital is equal to the family number. The elements in periods 5A, 6A, and 7A assume at least one ionic state equal to the negative value of the difference between 8 and the family number.

$$8 - \text{FAMILY } 6 = -2$$

Elements in the inert gas family generally do not assume ionic states. These elements all have eight electrons in their outer most or valence shell or energy level. These gases obtain their very stability or nonreactiveness because they have eight electrons in their outermost ring (He is the only exception - it has 2 electrons in its valence ring).

In Table 2 valence ring populations of the various elements have been arranged by period. Each successive element (as one proceeds from left to right across the periodic table) in the A-lettered families has one more valence electron than its predecessor. In each case a period has reached its maximum right hand extension when, as mentioned above, there are eight electrons in the outermost ring.

Table 3 presents electron distribution in the s, p, d, and f suborbitals. From this table it is easy to deduce that the maximum numbers of electrons which may be in s, p, d, and f suborbitals respectively are 2, 6, 10, and 14.

Table 4 presents the electron configurations of each of the elements according to the group in which they exist. From this table it is possible to see the energy levels (the periods) of all electrons belonging to each element. The energy levels are the coefficients of the s, p, d, and f orbitals. The electron population of each element may also be determined from this table. These populations are found by adding the superscripts of each the s, p, d, and f orbitals of each element.

Table 5 provides the ionization energies by family for the first three periods of the periodic table. From the data presented in this table a tremendous increase in ionization energy/mole is noted with the ionization constant following the number of the family in which the element resides. Also, generally speaking, there is a decrease in ionization energy as one proceeds from the top to the bottom of the periodic table.

Tables 6 and 7 consider atomic and ionic radii by group and period respectively. As might be predicted both atomic and ionic radii increase as one proceeds from top to bottom of the periodic table.

An evaluation of radii trends by period show that as the magnitude of the positive oxidation state increases a decrease in radii occurs. The converse of this trend occurs as the magnitude of the negative oxidation number increases.

CONCLUSIONS

While all identifiable trends have not been discussed, across and down the periodic table, many of the most visible trends have. It is possible to locate and evaluate all trends found throughout the periodic table by dissecting a handbook of chemistry and physics.

- FIGURE #1 -

Periodic Chart of the Elements

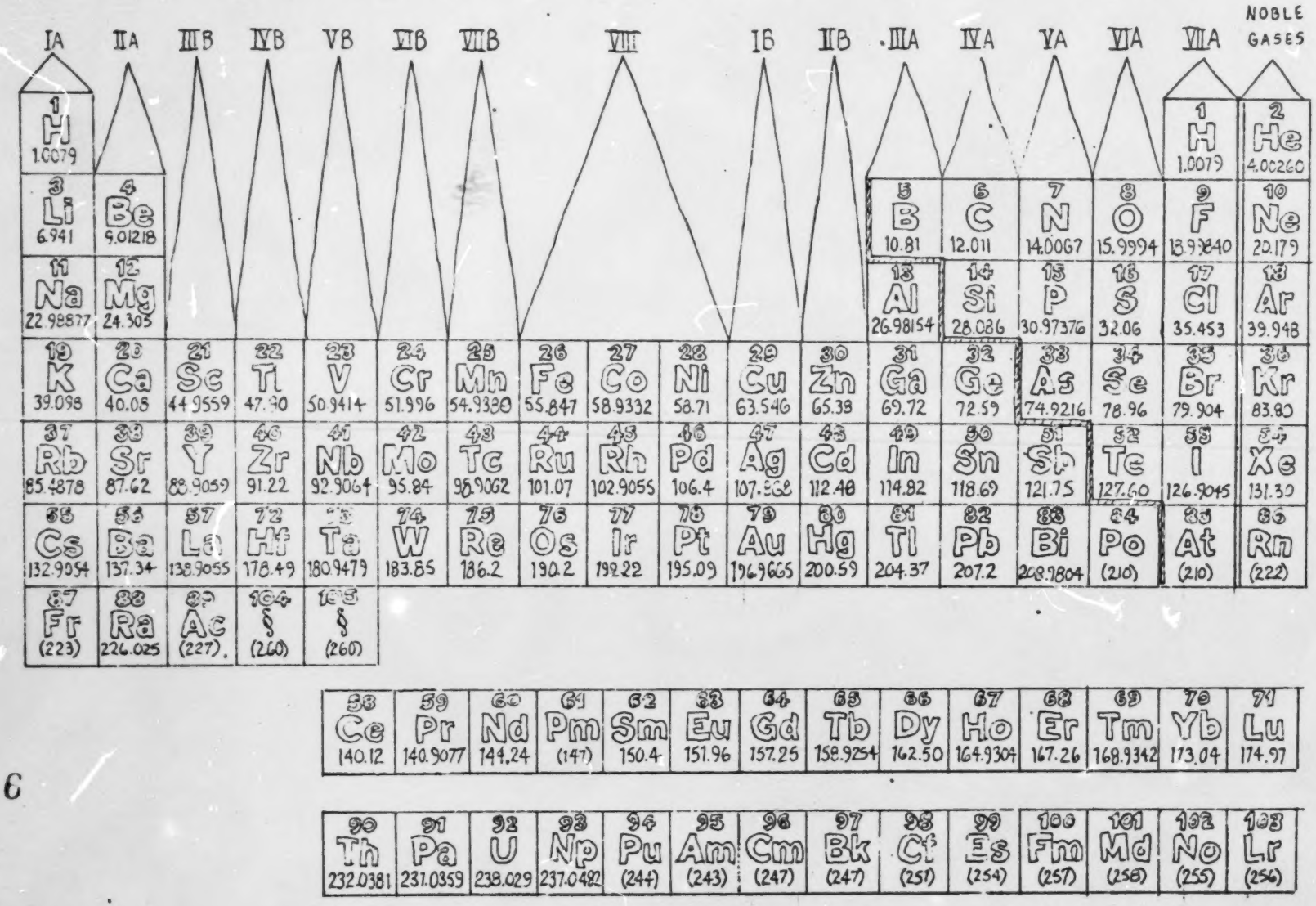

TABLE 1

A BREAKDOWN OF THE PERIODIC TABLE BY GROUPS OR FAMILIES

FAMILY	PERIOD	ELEMENT SYMBOL	ELEMENT NUMBER	COMMON IONIC STATE/STATES	ELECTRON POPULATIONS BY ORBITS K 1	L 2	M 3	N 4	O 5	P 6	Q 7
1A	1	H	1	1^+	1*						
1A	2	Li	3	1^+	2	1*					
1A	3	Na	11	1^+	2	8	1*				
1A	4	K	19	1^+	2	8	8	1*			
1A	5	Rb	37	1^+	2	8	18	8	1*		
1A	6	Cs	55	1^+	2	8	18	18	8	1*	
1A	7	Fr	87	1^+	2	8	18	32	18	8	1*
2A	2	Be	4	2^+	2	2*					
2A	3	Mg	12	2^+	2	8	2*				
2A	4	Ca	20	2^+	2	8	8	2*			
2A	5	Sr	38	2^+	2	8	18	8	2*		
2A	6	Ba	56	2^+	2	8	18	18	8	2*	
2A	7	Ra	88	2^+	2	8	18	32	18	8	2*
3A	2	B	5	3^+	2	3*					
3A	3	Al	13	3^+	2	8	3*				
3A	4	Ga	31	3^+	2	8	10	8	3*		
3A	5	In	49	3^+	2	8	18	10	8	3*	
3A	6	Tl	81	1^+, 3^+	2	8	18	32	10	8	3*
4A	2	C	6	2^+, 4^+, 4^-	2	4*					
4A	3	Si	14	2^+, 4^+, 4^-	2	8	4*				
4A	4	Ge	32	2^+, 4^+	2	8	10	8	4*		
4A	5	Sn	50	2^+, 4^+	2	8	18	10	8	4*	
4A	6	Pb	82	2^+, 4^+	2	8	18	32	10	8	4*
5A	2	N	7	1^+, 2^+, 3^+, 4^+, 5^+, 1^-, 2^-, 3^-	2	5*					
5A	3	P	15	2^+, 4^+, 4^-	2	8	5*				
5A	4	As	33	3^+, 5^+, 3^-	2	8	10	8	5*		
5A	5	Sb	51	3^+, 5^+, 3^-	2	8	18	10	8	5*	
5A	6	Bi	83	3^+, 5^+	2	8	18	32	10	8	5*
6A	2	O	8	2^-	2	6*					
6A	3	S	16	4^+, 6^+, 2^-	2	8	6*				
6A	4	Se	34	4^+, 6^+, 2^-	2	8	10	8	6*		
6A	5	Te	52	4^+, 6^+, 2^-	2	8	18	10	8	6*	
6A	6	Po	84	2^-, 4^+	2	8	18	32	10	8	6*
7A	1	F	9	1^+	2	7*					
7A	3	Cl	17	1^+, 5^+, 7^+, 1^-	2	8	7*				
7A	4	Br	35	1^+, 5^+, 1^-	2	8	10	8	7*		
7A	5	I	53	1^+, 5^+, 7^+, 1^-	2	8	18	10	8	7*	
7A	6	At	85	-	2	8	18	32	10	8	7*
0	1	He	2	0	2*						
0	2	Ne	10	0	2	8*					
0	3	Ar	18	0	2	8	8*				
0	4	Kr	36	0	2	8	18	8*			
0	5	Xe	54	0	2	8	18	18	8*		
0	6	Rn	86	0	2	8	18	32	10	8	8*
3B	4	Sc	21	3^+	2	8	9	2*			
3B	5	Y	39	3^+	2	8	18	9	2*		
3B	6	La	57	3^+	2	8	18	18	9	2*	
3B	7	Ac	89	3^+	2	8	18	32	18	9	2*
4B	4	Ti	22	2^+, 3^+, 4^+	2	8	10	2*			
4B	5	Zr	40	4^+	2	8	18	10	2*		
4B	6	Hf	72	4^+	2	8	18	32	10	2*	
4B	7	?	104	4^+	2	8	18	32	32	10	2*
5B	4	V	23	2^+, 3^+, 4^+, 5^+	2	8	11	2*			
5B	5	Nb	41	3^+, 5^+	2	8	18	12	1*		
5B	6	Ta	73	5^+	2	8	18	32	11	2*	
5B	7	?	105	-	2	8	18	32	32	11	2*
6B	4	Cr	24	2^+, 3^+, 6^+	2	8	13	1*			
6B	5	Mo	42	6^+	2	8	18	13	1*		
6B	6	W	74	6^+	2	8	18	32	13	1*	
6B	7	?	106	-	-						
7B	4	Mn	25	2^+, 3^+, 4^+, 7^+	2	8	13	2*			
7B	5	Tc	43	4^+, 6^+, 7^+	2	8	18	13	2*		
7B	6	Re	75	4^+, 6^+, 7^+	2	8	18	32	13	2*	

TABLE I (CONTINUED)

A BREAKDOWN OF THE PERIODIC TABLE BY GROUPS OR FAMILIES

FAMILY	PERIOD	ELEMENT SYMBOL	ELEMENT NUMBER	COMMON IONIC STATE/STATES	ELECTRON POPULATIONS BY ORBITS K 1	L 2	M 3	N 4	O 5	P 6	Q 7
8	4	Fe	26	2^+, 3^+	2	8	14	2*			
8	5	Ru	44	3^+	2	8	18	14	2*		
8	6	Os	76	3^+, 4^+	2	8	18	32	14	2*	
8	4	Co	27	2^+, 3^+	2	8	15	2*			
8	5	Rh	45	3^+	2	8	18	15	2*		
8	6	Ir	77	3^+, 4^+	2	8	18	32	15	2*	
8	4	Ni	28	2^+, 3^+	2	8	16	2*			
8	5	Pd	46	2^+, 4^+	2	8	18	18*			
8	6	Pt	78	2^+, 4^+	2	8	18	32	16	2*	
1B	4	Cu	29	1^+, 2^+	2	8	18	1*			
1B	5	Ag	47	1^+	2	8	18	18	1*		
1B	6	Au	79	1^+, 3^+	2	8	18	32	18	1*	
2B	4	Zr	30	2^+	2	8	18	2*			
2B	5	Cd	48	2^+	2	8	18	18	2*		
2B	6	Hg	80	1^+, 2^+	2	8	18	32	18	2*	

TABLE 2

VALENCE RING ELECTRON POPULATIONS BY PERIOD

PERIOD	GROUP OR FAMILY	ELEMENT #	ELEMENT	ELECTRON POPULATIONS IN VALENCE RINGS						
				K 1	L 2	M 3	N 4	O 5	P 6	Q 7
1	1A	1	H	1						
1	0	2	He	2						
2	1A	3	Li		1					
2	2A	4	Be		2					
2	3A	5	B		3					
2	4A	6	C		4					
2	5A	7	N		5					
2	6A	8	O		6					
2	7A	9	F		7					
2	0	10	Ne		8					
3	1A	11	Na			1				
3	2A	12	Ma			2				
3	3A	13	Mg			3				
3	4A	14	Si			4				
3	5A	15	P			5				
3	6A	16	S			6				
3	7A	17	Cl			7				
3	0	18	Ar			8				
4	1A	19	K				1			
4	2A	20	Ca				2			
4	3B	21	Sc				2			
4	4B	22	Ti				2			
4	5B	23	V				2			
4	6B	24	Cr				1			
4	7B	25	Mn				2			
4	8	26	Fe				2			
4	8	27	Co				2			
4	8	28	Ni				2			
4	1B	29	Cu				1			
4	2B	30	Zn				2			
4	3A	31	Ga				3			
4	4A	32	Ge				4			
4	5A	33	As				5			
4	6A	34	Se				6			
4	7A	35	Br				7			
4	0	36	Kr				8			
5	1A	37	Rb					1		
5	2A	38	Sr					2		
5	3B	39	Y					2		
5	4B	40	Zr					2		
5	5B	41	Nb					1		
5	6B	42	Mo					1		
5	7B	43	Tc					2		
5	8	44	Ru					1		
5	8	45	Rh					1		
5	8	46	Pd					18		
5	1B	47	Ag					1		
5	2B	48	Cd					2		
5	3A	49	In					3		
5	4A	50	Sn					4		
5	5A	51	Sb					5		
5	6A	52	Te					6		
5	7A	53	I					7		
5	0	54	Xe					8		
6	1A	55	Cs						1	
6	2A	56	Ba						2	
6	3B	57	La						2	
6	4B	72	Hf						2	
6	5B	73	Ta						2	
6	6B	74	W						1	
6	7B	75	Re						2	
6	8	76	Os						2	

TABLE 2 (CONTINUED)

VALENCE RING ELECTRON POLULATIONS BY PERIOD

PERIOD	GROUP OR FAMILY	ELEMENT #	ELEMENT	ELECTRON POPULATIONS IN VALENCE RINGS						
				K 1	L 2	M 3	N 4	O 5	P 6	Q 7
6	8	77	Ir						2	
6	8	78	Pt						2	
6	1B	79	Au						1	
6	2B	80	Hg						2	
6	3A	81	Tl							3
6	4A	82	Pb							4
6	5A	83	Bi							5
6	6A	84	Po							6
6	7A	85	At							7
6	0	86	Rn							8
7	1A	87	Fr							1
7	2A	88	Ra							2
7	3B	89	Ac							3

TABLE 3

ELECTRONIC CONFIGURATIONS OF THE ELEMENTS

ATOMIC NUMBER	ELEMENT	ℓ orbitals																	
		s	s	p	s	p	d	s	p	d	f	s	p	d	f	s	p	d	f	s
1	H	1																	
2	He	2																	
3	Li	2	1																
4	Be	2	2																
5	B	2	2	1															
6	C	2	2	2															
7	N	2	2	3															
8	O	2	2	4															
9	F	2	2	5															
10	Ne	2	2	6															
11	Na	2	2	6	1														
12	Mg	2	2	6	2														
13	Al	2	2	6	2	1													
14	Si	2	2	6	2	2													
15	P	2	2	6	2	3													
16	S	2	2	6	2	4													
17	Cl	2	2	6	2	5													
18	Ar	2	2	6	2	6													
19	K	2	2	6	2	6		1											
20	Ca	2	2	6	2	6		2											
21	Sc	2	2	6	2	6	1	2											
22	Ti	2	2	6	2	6	2	2											
23	V	2	2	6	2	6	3	2											
24	Cr	2	2	6	2	6	5[x]	1											
25	Mn	2	2	6	2	6	5	2											
26	Fe	2	2	6	2	6	6	2											
27	Co	2	2	6	2	6	7	2											
28	Ni	2	2	6	2	6	8	2											
29	Cu	2	2	6	2	6	10[x]	1											
30	Zn	2	2	6	2	6	10	2											
31	Ga	2	2	6	2	6	10	2	1										
32	Ge	2	2	6	2	6	10	2	2										
33	As	2	2	6	2	6	10	2	3										
34	Se	2	2	6	2	6	10	2	4										
35	Br	2	2	6	2	6	10	2	5										
36	Kr	2	2	6	2	6	10	2	6										
37	Rb	2	2	6	2	6	10	2	6			1							
38	Sr	2	2	6	2	6	10	2	6			2							
39	Y	2	2	6	2	6	10	2	6	1		2							
40	Zr	2	2	6	2	6	10	2	6	2		2							
41	Nb	2	2	6	2	6	10	2	6	4[x]		1							
42	Mo	2	2	6	2	6	10	2	6	5		1							
43	Tc	2	2	6	2	6	10	2	6	6		1							
44	Ru	2	2	6	2	6	10	2	6	7		1							
45	Rh	2	2	6	2	6	10	2	6	8		1							
46	Pd	2	2	6	2	6	10	2	6	10[x]									
47	Ag	2	2	6	2	6	10	2	6	10		1							
48	Cd	2	2	6	2	6	10	2	6	10		2							
49	In	2	2	6	2	6	10	2	6	10		2	1						
50	Sn	2	2	6	2	6	10	2	6	10		2	2						
51	Sb	2	2	6	2	6	10	2	6	10		2	3						
52	Te	2	2	6	2	6	10	2	6	10		2	4						
53	I	2	2	6	2	6	10	2	6	10		2	5						
54	Xe	2	2	6	2	6	10	2	6	10		2	6						
55	Cs	2	2	6	2	6	10	2	6	10		2	6			1			
56	Ba	2	2	6	2	6	10	2	6	10		2	6			2			
57	ha	2	2	6	2	6	10	2	6	10		2	6	1		2			
58	Ce	2	2	6	2	6	10	2	6	10	2[x]	2	6			2			
59	Pr	2	2	6	2	6	10	2	6	10	3	2	6			2			
60	Nd	2	2	6	2	6	10	2	6	10	4	2	6			2			
61	Pm	2	2	6	2	6	10	2	6	10	5	2	6			2			
62	Sm	2	2	6	2	6	10	2	6	10	6	2	6			2			
63	Eu	2	2	6	2	6	10	2	6	10	7	2	6			2			
64	Gd	2	2	6	2	6	10	2	6	10	7[x]	2	6	1		2			

TABLE 3 (CONTINUED)

ELECTRONIC CONFIGURATIONS OF THE ELEMENTS

ATOMIC NUMBER	ELEMENT	& orbitals																	
		s	s	p	s	p	d	s	p	d	f	s	p	d	f	s	p	d	f	s
65	Tb	2	2	6	2	6	10	2	6	10	9	2	6			2				
66	Dy	2	2	6	2	6	10	2	6	10	10	2	6			2				
67	Ho	2	2	6	2	6	10	2	6	10	11	2	6			2				
68	Er	2	2	6	2	6	10	2	6	10	12	2	6			2				
69	Tm	2	2	6	2	6	10	2	6	10	13	2	6			2				
70	Yb	2	2	6	2	6	10	2	6	10	14	2	6			2				
71	Lu	2	2	6	2	6	10	2	6	10	14	2	6	1		2				
72	Hf	2	2	6	2	6	10	2	6	10	14	2	6	2		2				
73	Ta	2	2	6	2	6	10	2	6	10	14	2	6	3		2				
74	W	2	2	6	2	6	10	2	6	10	14	2	6	4		2				
75	Re	2	2	6	2	6	10	2	6	10	14	2	6	5		2				
76	Os	2	2	6	2	6	10	2	6	10	14	2	6	6		2				
77	Ir	2	2	6	2	6	10	2	6	10	14	2	6	7		2				
78	Pt	2	2	6	2	6	10	2	6	10	14	2	6	9		1				
79	Au	2	2	6	2	6	10	2	6	10	14	2	6	10		1				
80	Hg	2	2	6	2	6	10	2	6	10	14	2	6	10		2				
81	Tl	2	2	6	2	6	10	2	6	10	14	2	6	10		2	1			
82	Pb	2	2	6	2	6	10	2	6	10	14	2	6	10		2	2			
83	Bi	2	2	6	2	6	10	2	6	10	14	2	6	10		2	3			
84	Po	2	2	6	2	6	10	2	6	10	14	2	6	10		2	4			
85	At	2	2	6	2	6	10	2	6	10	14	2	6	10		2	5			
86	Rn	2	2	6	2	6	10	2	6	10	14	2	6	10		2	6			
87	Fr	2	2	6	2	6	10	2	6	10	14	2	6	10		2	6			1
88	Ra	2	2	6	2	6	10	2	6	10	14	2	6	10		2	6			2
89	Ac	2	2	6	2	6	10	2	6	10	14	2	6	10		2	6	1		2
90	Th	2	2	6	2	6	10	2	6	10	14	2	6	10		2	6	2		2
91	Pa	2	2	6	2	6	10	2	6	10	14	2	6	10	2*	2	6	1		2
92	U	2	2	6	2	6	10	2	6	10	14	2	6	10	3	2	6	1		2
93	Np	2	2	6	2	6	10	2	6	10	14	2	6	10	4	2	6	1		2
94	Pu	2	2	6	2	6	10	2	6	10	14	2	6	10	6*	2	6			2
95	Am	2	2	6	2	6	10	2	6	10	14	2	6	10	7	2	6			2
96	Cm	2	2	6	2	6	10	2	6	10	14	2	6	10	7	2	6	1		2
97	Bk	2	2	6	2	6	10	2	6	10	14	2	6	10	9*	2	6			2
98	Cf	2	2	6	2	6	10	2	6	10	14	2	6	10	10	2	6			2
99	Es	2	2	6	2	6	10	2	6	10	14	2	6	10	11	2	6			2
100	Fm	2	2	6	2	6	10	2	6	10	14	2	6	10	12	2	6			2
101	Md	2	2	6	2	6	10	2	6	10	14	2	6	10	13	2	6			2
102	No	2	2	6	2	6	10	2	6	10	14	2	6	10	14	2	6			2
103	Lr	2	2	6	2	6	10	2	6	10	14	2	6	10	14	2	6	1		2
104	Rf	2	2	6	2	6	10	2	6	10	14	2	6	10	14	2	6	2		2

* Does not follow the predicted order

TABLE 4

ELECTRON CONFIGURATIONS OF ELEMENTS BY GROUP

GROUP	ATOMIC NUMBER	ELEMENT	ELECTRON CONFIGURATION
I A	1	H	$1s^1$
I A	3	Li	He + $2s^1$ (He = $1s^2$)
I A	11	Na	Ne + $3s^1$ (Ne = $2s^2 2p^6$)
I A	19	K	Ar + $4s^1$ (Ar = Ne + $2s^2 3p^6$)
I A	37	Rb	Kr + $5s^1$ (Kr = Ar + $4s^2 3d^{10} 4p^6$)
I A	55	Cs	Xe + $6s^1$ (Xe = Kr + $5s^2 4d^{10} 5p^6$)
I A	87	Fr	kn + $7s^1$ (Rn = Xe + $6s^2 4f^{14} 5d^{10} 6p^6$)
II A	4	Be	He + $2s^2$
II A	12	Mg	Ne + $3s^2$
II A	20	Ca	Ar + $4s^2$
II A	38	Sr	Kr + $5s^2$
II A	56	Ba	Xe + $6s^2$
II A	88	Ra	Rn + $7s^2$
III B	21	Sc	Ar + $4s^2 3d^1$
III B	39	Y	Kr + $5s^2 4d^1$
III B	57	La	Xe + $6s^2 5d^1$
III B	89	Ac	Rn + $7s^2 6d^1$
IV B	22	Ti	Ar + $3s^2 3d^2$
IV B	40	Zr	Kr + $5s^2 4d^2$
IV B	72	Hf	Xe + $6s^2 4f^{14} 5d^2$
V B	23	V	Ar + $4s^2 3d^3$
V B	41	Nb	Kr + $5s^1 4d^4$
V B	73	Ta	Xe + $6s^2 4f^{14} 5d^3$
VI B	24	Cr	Ar + $4s^1 3d^5$
VI B	42	Mo	Kr + $5s^1 4d^5$
VI B	74	W	Xe + $6s^2 4f^{14} 5d^4$
VII B	25	Mn	Ar + $4s^2 3d^5$
VII B	43	Tc	Kr + $5s^2 4d^5$
VII B	75	Re	Xe + $6s^2 4f^{14} 5d^5$
VIII	26	Fe	Ar + $4s^2 3d^6$
VIII	44	Ru	Kr + $5s^1 4d^7$
VIII	76	Os	Xe + $6s^2 4f^{14} 5d^6$
VIII	27	Co	Ar + $4s^2 3d^7$
VIII	45	Rh	Kr + $5s^1 4d^8$
VIII	77	Ir	Xe + $6s^2 4f^{14} 5d^7$
VIII	28	Ni	Ar + $4s^2 3d^8$
VIII	46	Pd	Kr + $4d^{10}$
VIII	78	Pt	Xe + $6s^1 4f^{14} 5d^9$
I B	29	Cu	Ar + $4s^1 3d^{10}$
I B	47	Ag	Kr + $5s^1 4d^{10}$
I B	79	Au	Xe + $6s^1 4f^{14} 5d^{10}$
II B	30	Zn	Ar + $4s^2 3d^{10}$
II B	48	Cd	Kr + $5s^2 4d^{10}$
II B	80	Hg	Xe + $6s^2 4f^{14} 5d^{10}$
III A	5	B	He + $2s^2 2p^1$
III A	13	Al	Ne + $3s^2 3p^1$
III A	31	Ga	Ar + $4s^2 3d^{10} 4p^1$
III A	49	In	Kr + $5s^2 4d^{10} 5p^1$
III A	81	Tl	Xe + $6s^2 4f^{14} 5d^{10} 6p^1$
IV A	6	C	He + $2s^2 2p^2$
IV A	14	Si	Ne + $3s^2 3p^2$
IV A	32	Ge	Ar + $4s^2 3d^{10} 4p^2$
IV A	50	Sn	Kr + $5s^2 4d^{10} 5p^2$
IV A	82	Pb	Xe + $6s^2 4f^{14} 5d^{10} 6p^2$
V A	7	N	He + $2s^2 2p^3$
V A	15	P	Ne + $3s^2 3p^3$
V A	33	As	Ar + $4s^2 3d^{10} 4p^3$
V A	51	Sb	Kr + $5s^2 4d^{10} 5p^3$
V A	83	Bi	Xe + $6s^2 4f^{14} 5d^{10} 6p^3$
VI A	8	O	He + $2s^2 2p^4$
VI A	16	S	Ne + $3s^2 3p^4$
VI A	34	Se	Ar + $4s^2 3d^{10} 4p^4$
VI A	52	Te	Kr + $5s^2 4d^{10} 5p^4$
VI A	84	Po	Xe + $6s^2 4f^{14} 5d^{10} 6p^4$
VII A	9	F	He + $2s^2 2p^5$

TABLE 4 (CONTINUED)

ELECTRON CONFIGURATIONS OF ELEMENTS BY GROUP

GROUP	ATOMIC NUMBER	ELEMENT	ELECTRON CONFIGURATION
VII A	17	Cl	Ne + $3s^2 3p^5$
VII A	35	Br	Ar + $4s^2 3d^{10} 4p^5$
VII A	53	I	Kr + $5s^2 4d^{10} 5p^5$
VII A	85	At	Xe + $6s^2 4f^{14} 5d^{10} 6p^5$
0	2	He	$1S^2$
0	10	Ne	He + $2s^2 2p^6$
0	18	Ar	Ne + $3s^2 3p^6$
0	36	Kr	Ar + $4s^2 3d^{10} 4p^6$
0	54	Xe	Kr + $5s^2 4d^{10} 5p^6$
0	86	Rn	Xe + $6s^2 4f^{14} 5d^{10} 6p^6$

TABLE 5

IONIZATION ENERGIES IN K JOULES/MOLE BY FAMILY FOR THE FIRST THREE PERIODS

FAMILY	ELEMENT	FIRST	SECOND	THIRD	FOURTH	FIFTH	SIXTH	SEVENTH	EIGHTH
I A	H	1312							
I A	Li	520	7297	11810					
I A	Na	495.8	4565	6912	9540	13360	16610	20110	25490
I A	K	418.8	3069	4600	5879	7971	9619	11380	14950
II A	Be	900	1757	14840	21000				
II A	Mg	737.6	1450	7732	10550	13620	18000	21700	25660
II A	Ca	598.5	1146	4941	6485	8142	10520	12350	13830
III A	B	800	2430	3659	25020	32810			
III A	Al	577.4	1816	2744	11580	15030	18370	23290	27460
IV A	C	1086	2352	4619	6221	37800	47300		
IV A	Si	786.2	1577	3229	4356	16080	19790	23780	29250
V A	N	1402	2857	4577	7473	9443	53250	64340	
V A	P	1012	1896	2910	4954	6272	21270	25410	29840
VI A	O	1314	3391	5301	7468	10980	13320	71300	84050
VI A	S	999.6	2260	3380	4565	6996	8490	28080	13720
VII A	F	1681	3375	6045	8418	11020	15160	17860	92000
VII A	Cl	1255	2297	3850	5146	6544	9330	11020	33600
0	He	2371	5247						
0	Ne	2080	3963	6276	9376	12190	15230		
0	Ar	1520	2665	3947	5770	7240	8810	11970	13840

TABLE 6

ATOMIC AND IONIC RADII (IN ANGSTROMS) BY GROUP

GROUP	ELEMENT	PERIOD	ATOMIC RADIUS	IONIC RADIUS	CHARGE	VALENCE E⁻
I A	Li	2	1.35	0.60	+ 1	$2s^1$
I A	Na	3	1.54	0.95	+ 1	$3s^1$
I A	K	4	1.96	1.33	+ 1	$4s^1$
I A	Rb	5	2.11	1.48	+ 1	$5s^1$
I A	Cs	6	2.25	1.69	+ 1	$6s^1$
II A	Be	2	0.90	0.31	+ 2	$2s^2$
II A	Mg	3	1.35	0.65	+ 2	$3s^2$
II A	Ca	4	1.74	0.99	+ 2	$4s^2$
II A	Sr	5	1.92	1.13	+ 2	$5s^2$
II A	Ba	6	1.98	1.35	+ 2	$6s^2$
III A	Al	3	1.43	0.50	+ 3	$3s^2 3p^1$
III A	Ga	4	1.22	0.62	+ 3	$4s^2 4p^1$
III A	In	5	1.62	0.81	+ 3	$5s^2 5p^1$
V A	N	2	0.70	1.71	- 3	$2s^2 2p^3$
V A	P	3	1.10	2.12	- 3	$3s^2 3p^3$
VI A	O	2	0.66	1.40	- 2	$2s^2 2p^4$
VI A	S	3	1.04	1.84	- 2	$3s^2 3p^4$
VI A	Se	4	1.17	1.98	- 2	$4s^2 4p^4$
VI A	Te	5	1.37	2.21	- 2	$5s^2 5p^4$
VII A	F	2	0.64	1.36	- 1	$3s^2 3p^5$
VII A	Cl	3	0.99	1.81	- 1	$3s^2 3p^5$
VII A	Br	4	1.14	1.95	- 1	$4s^2 4p^5$
VII A	I	5	1.33	2.16	- 1	$5s^2 5p^5$

TABLE 7

ATOMIC AND IONIC RADII (IN ANGSTROMS) BY PERIOD

PERIOD	ELEMENT	GROUP	ATOMIC NUMBER	ATOMIC RADIUS	IONIC RADIUS	CHARGE
2	Li	I A	3	1.35	0.60	+ 1
2	Be	II A	4	0.90	0.31	+ 2
2	N	V A	5	0.70	1.71	- 3
2	O	VI A	6	0.66	1.40	- 2
2	F	VII A	7	0.64	1.36	- 1
3	Na	I A	11	1.54	0.95	+ 1
3	Mg	II A	12	1.35	0.65	+ 3
3	Al	III A	13	1.43	0.50	+ 3
3	P	V A	15	1.10	2.12	- 3
3	S	VI A	16	1.04	1.84	- 2
3	Cl	VII A	17	0.99	1.81	- 1
4	K	I A	19	1.96	1.33	+ 1
4	Ca	II A	20	1.74	0.99	+ 2
4	Ga	III A	31	1.22	0.62	+ 3
4	Se	VI A	34	1.17	1.98	- 2
4	Br	VII A	35	1.14	1.95	- 1
5	Rb	I A	37	2.11	1.48	+ 1
5	Sr	II A	38	1.92	1.13	+ 2
5	In	III A	49	1.62	0.81	+ 3
5	Te	VI A	52	1.37	2.21	- 2
5	I	VII A	53	1.33	2.16	- 1
6	Cs	I A	55	2.25	1.69	+ 1
6	Ba	II A	56	1.98	1.35	+ 2